General Application Name: County Executive & Board of Supervisors

Product / Service / Function Name: Capital Improvement Project Analysis

P/S/F Description:

Capital improvements projects (CIP) may be defined as permanent additions to a government entity's fixed assets of major importance and cost. A capital improvement may include land acquisition, construction, reconstruction, renovation, demolition, equipment, and studies necessary to perform the actual project. They are often funded from a variety of sources including dedicated taxes, enterprise revenues, general municipal funds, and debt instruments. A capital improvement project generally possesses the following characteristics:

- Serves an essential public purpose
- Long, useful life or significantly extends the useful life of an existing fixed asset
- Comparatively expensive and is not of routine nature
- Fixed in place or stationary
- Related to government functions and expenditures
- Usual responsibility of a local government

To evaluate potential CIPs, a municipality must have an up-to-date inventory of its assets, including utilities, streets, parks, schools, and public safety. Also influencing CIPs are comprehensive plans, which define the future goals for the municipality. GIS technology is an ideal aid not only because it can help identify future projects through analyzing existing assets, but it can also help evaluate the effectiveness of these programs after the fact.

Product / Service / Function

1. Spatial Data

Minimum Data Requirements

General Description	GIS Data Layer
Utilities Data	Water Lines
	Storm Water Drainage
	Sewer Lines
Transportation	Road centerlines
	Right-of-way and/or edge of pavement
Natural Features	Streams
	Lakes
	Parks
Socio-Political Data	CIP locations
	Parcels
	Municipal boundaries
	Zoning
	Land Use
	Neighborhoods & Subdivisions

GeoDecisions
11838 Rock Landing Dr., Suite 200
Newport News, VA 23606
757-873-0768
www.geodecisions.com

Optional Data Requirements

General Description	GIS Data Layer
Planimetrics/Base Mapping	Orthophotography
Utilities	Gas
	Electric
Natural Features	Vegetation
	Flood zones
Transportation	Railroads
	Driveways
	Parking Lots
Socio-Political Data	Census Block/Tract
	School Zones
	Fire rescue zones
	Police beats

2. Attribute Data

Minimum Attribute Requirements

GIS Data Layer	Attributes
CIP Locations	Project Number
	Project Name
	Project Objectives
	Project Description
	Operating Budget Impact
	Budget for FY 20xx-20xx
	Project Start Date
	Project End Date
	Program
	District
	County
	Project Manager
Water Lines	*see Pipes Inventory topic*
Sewer Lines	*see Pipes Inventory topic*
Streets	Address Ranges
	Street Name
Land Use	Land Use Description

Optional Attribute Requirements

GIS Data Layer	Attributes
CIP Locations	Address
	Property Owner
	Project Start Date
	Project End Date
	Cost
	Funding Source
	Project Manager

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	Description
Socio-Political	City/County boundaries
Water Lines	*see Pipes Inventory topic*
Sewer Lines	*see Pipes Inventory topic*

3. Data Acquisition Options (integrated with VBMP digital orthos)

   The CIP data layer is a layer showing where each project is located within the municipality. This layer can be created by "head ups" digitizing on top of the VBMP orthophotos or other base data. Or, if there are several CIPs to locate, one could geocode the addresses to the street centerlines. A CIP layer is necessary to visualize the distribution of CIPs.

   Planimetric data such as parcels, utilities, buildings, land use, streets, etc. are typically maintained at the county or city level. Street centerline data layers of varying qualities can be obtained from a number of vendors. The market is relatively competitive, and prices will vary with quality of the data. Relevant vendors that provide this kind of spatial data on a regional and national scale include: NAVTECH <www.navtech.com>, GDT <www.geographic.com>, and TeleAtlas <www.teleatlas.com>.

   Additional spatial data layers can be obtained through the Internet from various government sources. Municipal boundaries and similar layers can be obtained in digital format through the U.S. Census Bureau <www.census.gov>. Floodplains can be obtained through the FEMA Web site <www.fema.com>.

   Regardless of the source of the data, each data layer used to build the CIP analysis application should be consistent with, or be modified to match, the projection of the Virginia Base Mapping Project (VBMP) orthophotography. The digital orthophotography serves as a base layer on which to display the CIP locations and associated information.

4. Data Conflation Options (integrated with VBMP digital orthos)

   Data conflation is a process by which two digital data layers, usually of the same area at different points in time, or two different data layers of the same area, are geographically "corrected" through geometrical and rotational transformations so that the different layers can be overlaid on one another. Also called "rubber-sheeting," this process allows a technician to adjust the coordinates of all features on a data layer to provide a more accurate match between known locations and a few data points within the base data set. A good base layer to use for data conflation is the VBMP orthophotos since many features can be seen or interpreted. The need and processes for conflation varies between sets of data, users, and feature types. Any dataset that is updated independently by different departments can be consolidated through conflation. Within most local governments, individual departments are responsible for maintaining specific datasets within their expertise; therefore, conflation is not often necessary. Often, reprojecting the data into a different coordinate system will take care of the misalignment of different data sets. Most industry-standard GIS software has the ability to perform data conflation.

   The easiest way to locate existing or potential CIP locations is to digitize them directly on top of the VBMP orthophotos. However, any data supporting CIP identification must be conflated to match the VBMP orthophotography as well.

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5. GUI / programming options

There are a few options for developers of a GIS-based CIP analysis application. Two avenues within this development track are:

- Off-the-shelf GIS desktop application that can be customized to the user's needs
- Hiring a consultant to develop a custom system from scratch.

Using a standard GIS software package often requires a significant amount of training and customization. Whereas the initial cost may be lower, the time invested in learning these solutions may generally increase the overall expense of implementation. However, standard GIS software packages deliver more robust data integration, analysis, and cartographic capabilities than do other specialized commercial applications. They have a greater user support infrastructure that allows users to overcome problems quickly. Options for using an existing, industry-standard GIS software application that can be customized for CIP analysis include those listed in the following table:

Standard GIS Software Vendors:

Vendor	Software	Web Address
ESRI	ArcView 3.x	http://www.esri.com
ESRI	ArcGIS 8.x	http://www.esri.com
MapInfo	Professional 7.0	http://www.mapinfo.com
Intergraph	GeoMedia 5.0	http://www.intergraph.com/gis
Autodesk	Map 5.0	http://www.autodesk.com

The second option is to contract with a consultant to develop and implement a tailored CIP analysis application. The advantage of a tailored application over a standard GIS application is that it provides just the functionality that is needed, decreasing the overall computer program's overhead common to industry-standard GIS software. This option makes certain that a product will fulfill a jurisdiction's requirements. A consultant will be able to develop an application that works with the wide range of hardware and software that are currently in use within local governments within Virginia. Also, training and follow-up user support is often provided at a much more substantial level than with other options.

There are a number of functions that a GIS application could perform for CIP analysis. A GIS has the ability to analyze locational information and the relationships between projects of different types in a given geographic area. For example, it is possible for a user to determine the total dollars spent on projects by district or neighborhood over time, to compare the use of certain revenue streams over the life of different projects, to compare asset values with dollars spent to renovate them, or to print specialized maps. This type of application would be very powerful and would greatly assist the City Council in making sure that chosen projects are justified and at that no area of City/County is overlooked for new projects.

6. Internet Functionality and options

The Internet has proven itself as a viable solution for local governments to centralize the maintenance and management of services and data. As more local governments are implementing Web-based solutions, they are finding that the Internet requires them to change the nature of an application or its usefulness. Through the flexibility of an Internet solution, software

can be easily updated, and users gain greater accessibility to the applications and information they need for their specific tasks through simple, user-friendly interfaces.

An application can be deployed on the Web to allow an even greater access to this information for the community. The public could visit the web site to view maps of all CIP locations in their neighborhood as well and links to budget information concerning the projects. GIS software vendors have products that can be customized in-house or by a consultant to provide Web GIS applications on the Internet, over an intranet or via wireless network. The table below shows GIS vendors and their Internet mapping solutions.

GIS Internet Solutions

Vendor	Internet Software	Web Address
ESRI	ArcIMS	http://www.esri.com/software/arcims
MapInfo	MapXtreme, MapX	http://www.mapinfo.com
Intergraph	GeoMedia WebMap	http://www.intergraph.com/gis/gmwm
Autodesk	MapGuide	http://www.autodesk.com

7. Technical Requirements

Minimum Technical Requirements
At its most basic level, a GIS-based CIP analysis application can be used on a single, stand-alone workstation. This workstation would have a hard drive that stores all of the spatial data layers, as well as the GIS software package or application itself. A typical workstation running off-the-shelf software should have the following minimum specifications:

Processor: Pentium 3; 450 MHz
RAM: 128MB SDRAM at 133MHz
Hard Disk: 20GB (min.)
Monitor 1: 19"
Floppy Drive: 3.5”
CD-ROM: 12x/8x/32x CD drive
Modem: 56K
OS: Windows 2000/NT/XP
Office: Windows 2000 Professional
Printer: 8x11 office-grade color printer

Optimum Technical Requirements:
A more complex application may require multiple components, including servers, desktop workstations, or handheld devices. For either a desktop or a Web-based application, the system should rely on a fairly robust server computer and high-end workstations. Example specifications of the necessary equipment are listed below:

Server
Processor: Min. 2 Processors, 1.7 GHz, 512K cache
RAM: Min. 2x 512MB RIMMS
Hard Disk: Min. 2x 80GB +RAID
Monitor 1: 19"
Floppy Drive: 3.5”

CD-ROM:	12x/8x/32x CD drive
Modem:	56K
Network Card:	10/100 mbps

Workstation

Processor:	Pentium 4, 1.5 GHz
RAM:	512MB SDRAM at 133MHz
Hard Disk:	20GB (min.)
Monitor 1:	19”
Monitor 2:	17”
Floppy Drive:	3.5”
CD-ROM:	12x/8x/32x CD-RW drive
Modem:	56K
Network Card:	10/100 mbps
OS:	Windows 2000/NT/XP
Office:	Windows 2000 Professional

Other Components

Printer:	8x11 office-grade color printer and 8x11 production b/w printer
Plotter:	HP DesignJet 1055CM
Tape Backup:	Tape Library Server
UPS:	APC 1400 (or other similar)
Scanner:	11x17
Handheld:	Compaq IPAQ
Network:	T1

8. Administrative/Management Requirements

At the beginning of the project, the assigned committee member from the particular municipality should consider completing some, if not all of the following tasks that relate to the administrative requirements of a CIP analysis system:

- Determine, with or without the assistance of a consultant hired to develop the system, the preliminary vision and goals of the project.
- Coordinate an initial meeting with the stakeholders (e.g. Board of Supervisors, City Council, planning department, public works department, etc.) where the vision and goals of the project are expressed and the background of GIS technology is described, if needed.
- Coordinate with other municipal agencies for data sharing provisions.
- Determine a mechanism of communication to keep the decision-makers aware of the progress of the project.
- Develop a basic understanding of the available precedents in the region/state and research the available technologies that can be applied to the project.

Upon project completion, a basic GIS-based CIP analysis application will require very little administrative support. Administrative tasks may include loading or upgrading new versions of the software or patches, providing for constant data flow, and maintaining yearly support contracts on the hardware and software. However, once the system becomes distributed as an enterprise solution to many users throughout a department or deployed on the Internet, there are various other management requirements that need to be fulfilled on a weekly or monthly basis.

At the point where the system grows beyond single desktop users, a devoted administrator or system manager needs to be established. This is essential for the following reasons:

- The system will now be interfacing with other technology systems already in place. Therefore, someone needs to maintain contact with the technology personnel that maintain these systems.
- The manager needs to put into place training schedules to maintain user knowledge of the system.
- Funding will undoubtedly be required to either maintain the system long-term, or continue to expand the system, which requires funding research and applications for grants.

9. Cost – Cost/Benefit

Hardware	**Typical Unit Cost**
Minimum Workstation	$2,000
Optimum Workstation	$3,200
Laptop	$2,400
Web/FTP Server	$8,500
Database Server	$12,000
Data Warehouse Server	$18,000
Backup Server	$5,800
Printer (8x11 color)	$700
Printer (8x11 b/w production)	$2,000
Plotter	$12,000
Tape Library	$5,000
UPS (Universal Power Supply)	$700
Scanner	$1,500
Handheld	$300-$700

Software (all prices included license)	**Typical Unit Cost**
Standard GIS desktop software	$700-$10,000
Customized desktop vendor solution	$5,000-$15,000
Web-based vendor application	$15,000-$25,000
Customized web-based vendor solution	$20,000-$60,000

Miscellaneous	**Typical Unit Cost**
Training – general GIS	$700-$1,200
Licensing – desktop	$100-$500
Licensing – webapp (1st CPU)	$7,500-$12,000
Maintenance (per year)	$8,000-$15,000

10. Standards / Guidelines Summary
    - Consider creating or purchasing an application that integrates CIP analysis with other government information management tools such as asset inventory, comprehensive planning, or zoning.
    - Design the system so several departments, including County Commissioners, Fiscal Directors, and Grants Writers can benefit from its use.

- A GIS-based CIP analysis application should be built so that non-technical personnel can be trained to use the system.
- Acquire input from all departments who will be involved in funding and/or utilizing the application before proceeding with the application design.
- Create a procedure for acquiring the locations of new CIP projects, so that the CIP data layer is kept up-to-date.
- The status of the CIP should be tracked through the use of an attribute (proposed, under construction, completed, etc.).
- Develop a detailed Quality Assurance/Quality Control (QA/QC) procedure for reviewing the accuracy of the GIS data and its attributes.
- Maintain data in the VBMP standard coordinate system (Virginia State Plane, NAD 83, Survey Feet).
- Create metadata (standard information about GIS data) for each data layer. Metadata tracks the date, origin, coordinate system, and other such information for data layers.

11. Startup Procedures/Steps

There should be a minimum of eight steps involved with developing a GIS-based CIP analysis application, after funding is in place to support the project. The steps can be performed in-house or by a consulting team.

The first task is to complete a detailed Needs Assessment. This process gathers information regarding existing operational procedures, hardware and software, GIS data, and personnel needs. It should include interviews of key individuals throughout the local government agency and other related government departments to obtain a comprehensive view of the agency's operations, and where GIS might improve them. Basic GIS concepts should be discussed and illustrated to those interviewees that have little prior understanding of GIS. A comprehensive Needs Assessment should then be compiled from the results of the interviews. This document explains the various requirements for a GIS-based CIP analysis application in the following areas: personnel needs, spatial data development needs, applicable spatial analysis techniques, basic system requirements, including preliminary, general hardware and software recommendations, and training needs.

The second task is to develop a functional requirements document for the proposed system. This document should describe, as completely as possible, all of the technology and functionality that is to be included in the CIP analysis system. This document is used by the local government agency, or its consultant, as the blueprint for the GIS application. The following topics should be included:

- Hardware specifications
- Software purchases
- Detailed descriptions of work-flow, and examples of the graphic user interfaces
- Describe each tool that is part of that graphic user interface, and its functionality
- Describe how data would flow between the different databases and data warehouses, if applicable
- Describe the redundant security measures that will be put in place to make certain of data integrity and confidentiality, when applicable
- Techniques that the application/system provides the user for CIP analysis
- Describe each of the potential products (reports, maps, charts, summary tables) that the user will be able to generate within the system

The third task should be to compile or develop spatial data that can be used by the evolving application. Data can be gathered from a number of online sources, as well as county/city departments. The data layers gathered and maintained should match at least the minimum list provided in Section 1 of this document and can be acquired through the methods described in Section 3 of this document.

On completion and acceptance of the functional requirements document and the development of the spatial and attribute data, the system development and test phase can begin. During this time, the application will be customized as it was outlined in the functional requirements phase. The local government agency should require periodic reviews of the application at particular milestones, such as 50% and 75% completion. This will make certain that problems with the application will be recognized early in the development process, and that the local government agency remains a part of the development process throughout the project timeline.

When the application is nearing 100% completion, it should be installed and tested in the environment in which it will ultimately be used. This allows the users to test the system alongside the application developers, and determine any system integration problems that might arise. It also gives the developers the opportunity to test the application's functionality in a real-world situation. This testing process should be as comprehensive as possible. Each process detailed within the functional requirements should be tested and evaluated at this point.

User training commences once the application reaches completion and is fully documented. Different levels of tutorials and system documentation should be developed depending on the hierarchy of users. Time should be spent at this stage of the project with each potential user of the system to make certain that the proper education occurs. Training should be done through lessons that use real-life examples of system application. This strategy greatly enhances users' ability to apply the functionality to their jobs.

The next phase of the project should include a document that describes a future plan for wider system development. This document accomplishes two goals. The future plan gives the local government agency ideas on how the system might grow to assist other facets of its business practices. Secondly, it provides the agency with a ready-made grant proposal for applying for potential funding sources.

The final phase of a successful implementation of a GIS-based CIP analysis application is ongoing technical support. The local government agency should always include this contingency within its cost estimates of a project for a minimum of three months after a system has been put into place. No matter how effective an application appears, problems and system changes inevitably impact the functionality of an application.

12. Estimated time line and/or implementation (stand alone) schedule

Phase	**Approximate Duration**
RFP/Contract process (construction, posting, proposal acceptance, review, award of contract)	4 months - 1 year
Needs Assessment	2 months
Functional Requirements	1-2 months
Data Development	6-12 months
System Development and Testing	2-4 months
Installation and Testing	1 month

User Training	½ month
Plan for Future Development	½ month
Ongoing Support	3 months

13. Best Practice Examples in Virginia

City of Hampton
Public Works
22 Lincoln Street, 4th Floor
Hampton, VA 23669
757-727-8311
http://www.hampton.va.us/publicworks/engineering_services_overview.html